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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Imin Kao			
Serial No.	:	09/674,822	Examiner	:	R. A. Rosenberger
Filed	:	January 29, 2001	Group Art Unit:		2877
For	:	SHADOW MOIRE SURFACE MEASUREMENT USING TALBOT EFFECT			

RESPONSE

I hereby certify that this paper is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on:

September 18, 2003
Date of Deposit

Paul A. Ragusa	38,587
Attorney Name	PTO Registration No
	September 18, 2003
Signature	Date of Signature

Commissioner for Patents
P.O. Box 1450
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Sir or Madam:

The Applicant respectfully petitions that the time within which the Applicant must respond to the Office Action mailed on March 18, 2003 be extended by three months. A check in the amount of $465.00 is enclosed, should there be additional fees the Commissioner is hereby authorized to charge any fees associated with this Response, or credit any overpayments made, to Deposit Account 02-4377.

This paper is submitted in response to the outstanding March 18th Office Action, in which claims 1 through 24 were rejected under 35 U.S.C. 103(a) as being obvious over U.S. Patent 3,858,981 ("Jaerisch") and U.S. Patent 5,311,286 ("Pike") in view of U.S. Patent No. 4,972,075 ("Hamada"). The Applicant respectfully requests reconsideration of the rejection of claims 1 through 24.

Of the rejected claims, 1 and 15 are in independent form. Claims 2-14 are dependent on claim 1, and claims 16 through 24 dependent on claim 15. Claims 1 and 15 recite, respectively, a method and apparatus for surface measurement. Claim 1 reads:

> 1. A method for surface measurement, comprising the steps of:
>
> (a) providing a specimen having a surface to be measured, said surface having a mean surface plane defined therefor;
>
> (b) ***supporting a reference grating at a distance δ_T from said mean surface plane and substantially parallel to said mean surface plane, said distance δ_T being a Talbot distance***, said reference grating having a pitch;
>
> (c) causing a first beam of light to be directed through said reference grating onto said surface to be measured, said first beam of light having a wavelength λ and ***casting a first reference grating shadow onto said surface*** to be measured, ***said first reference grating shadow forming a first effective specimen grating***; and
>
> (d) detecting ***moire fringes produced by said reference grating and said first effective specimen grating*** due to variations in depth of said surface to be measured, said moire fringes being indicative of a condition of said surface to be measured;
>
> wherein, in step (b), said Talbot distance δ_T is given by the formula:
>
> $$\delta_T = n(2p^2/\lambda)$$
>
> where: n=1, 2, . . . is a positive integer,
>
> p is said pitch of said reference grating, and
>
> λ is said given wavelength of said first beam of light.

(Emphasis supplied).

Claim 15, which is an apparatus claim that corresponds to claim 1, reads:

> 15. An apparatus for surface measurement of a specimen having a surface to be measured, the surface having by a mean surface plane defined therefor, said apparatus comprising:
>
> (a) a specimen mount which is adapted to receive the specimen;
>
> (b) a reference grating which is mounted adjacent said specimen mount and which positioned to be substantially parallel to the mean surface plane of the specimen when the specimen is received in said specimen mount, said reference grating and said specimen mount being movable with respect to each other so as to vary a distance δ_T between said reference grating and the mean surface plane of the specimen, said reference grating having a pitch;
>
> (c) a light source which is mounted to direct a first beam of light having a given wavelength through said reference grating onto the surface to be measured when the specimen is received in said specimen mount, ***said first beam of light casting a first reference grating shadow onto the surface to be measured, said first reference grating shadow forming a first effective specimen grating***; and
>
> (d) a detector which is positioned to detect ***moire fringes produced by said reference grating and said first effective specimen grating*** due to variation in depth of the surface to be measured, said moire fringes being indicative of the surface being measured;
>
> wherein said distance δ_T is selected to be a Talbot distance given by the formula:
>
> $\delta_T = n(2p^2/\lambda)$
>
> where: $n=1, 2, \ldots$ is a positive integer,
>
> p is said pitch of said reference grating, and
>
> λ is said given wavelength of said first beam of light.

(Emphasis supplied).

Thus, claims 1 through 24 are directed to a "shadow moire" technique of surface measurement. They each require that a light source direct a beam of light through a reference grating to cast a reference grating shadow on the surface to be measured. The reference grating

shadow and the reference grating produce moire fringes that are detected by a properly positioned detector. These moire fringes indicate variations in the surface being measured.

The combination of Jaerisch, Pike and Hamada fails to disclose or suggest the shadow moire surface measurement technique recited by claims 1 through 24, i.e., these references do not disclose, either individually or in combination, detecting moire fringes produced by a reference grating the reference grating shadow.

Jaerisch does not deal with shadow moire at all. Rather, Jaerisch discloses generating a diffraction pattern on a reflective surface (see reflecting surface 13 in FIG. 2, surface 49 in FIG. 4, and body 35 in FIG. 5, and accompanying discussion in the specification) by passing light through a diffraction grid positioned above the reflective surface. Moire fringes are formed in Jaerisch by reflecting the diffraction pattern from the reflective surface back onto the diffraction grid. It is from the reflection of this twice diffracted image that moire fringes are produced. That is to say, Jaerisch discloses producing moire fringes using a reflected double diffracted image, and not using a reference grating and reference grating shadow as required by claims 1 through 24.

Pike also fails to disclose producing moire fringes with a reference grating and a reference grating shadow as is required by claims 1 through 24. In Pike, the shadow of a grating pattern is projected onto the surface to be measured. However, unlike claims 1 through 24 of the present application, the moire fringe patterns are *not* produced by the reference grating and the reference grating shadow. Rather, in Pike, the moire fringe patterns are produced by superimposing an image of the reference grating shadow over an electronically generated reference set of parallel lines. (*See e.g.* Pike, col. 2, lines 37 – 45). Hamada also fails to

disclose or suggest producing moire fringes with a reference grating and a reference grating shadow. In Hamada, moire fringes are produced using two reference gratings.

Moreover, as the Office Action acknowledges, neither Jaerisch nor Pike discloses or suggests maintaining the reference grating at a Talbot distance from the surface to be measured, as is required by claims 1 through 24. The Office Action cites Hamada as curing this deficiency in Jaerisch and Pike, and states "it would have been obvious to place the grating in arrangements such as shown by Jaerisch et al and Pike at a Talbot distance to achieve this art-recognized benefit of a sharp image of the grating and a sharp moire pattern." *See* Office Action at p. 2 – 3.

However, the Applicant respectfully submits that one of skill in the art would not have been motivated to combine the teachings of Hamada with those of either Pike or Jaerisch in order to arrive at the invention recited in claims 1 through 24 of the present application. First, unlike Pike or Jaerisch which are directed to measurement of surface irregularities, Hamada describes an automatic focusing system adapted to detect focusing errors utilizing a moire pattern. The Office Action does not state any reason why one of ordinary skill in the art of surface area measurement would have looked to the teachings of an automatic focusing system.

Second, Hamada describes using two grids, and teaches that these two grids should be separated by a Talbot distance – which is a function of grating pitch and wavelength of the illuminating light – in order to achieve sharp moire patterns. By contrast, both Pike and Jaerisch use only a single diffraction grid, positioned at a certain height above the surface being measured. That height in both Jaerisch and Pike is a function of the illumination and/or viewing angles at the object's surface rather than a function of wavelength as in Hamada. (*See e.g.* Jaerisch at col. 5, ll. 59 – 67, col. 6 ll. 1 – 5; *see also* Pike at col. 6 ll. 18 – 25, col. 7 ll. 59 – 68, and col. 8, ll. 1 – 5). The Examiner fails to point to anything in the cited art that would have

motivated a person of ordinary skill in the art to modify the single grid systems of Jaerisch and Pike – in which the distance between the surface and the single grating is a function of the illumination and/or viewing angle – in view of Hamada's two grid system, in which that distance is a Talbot (i.e., wavelength dependent) distance.

Finally, the Applicant respectfully points out that the Examiner failed to explain how the cited art renders each of the dependent claims obvious. For example, the Examiner does not allege that the combination of Jaerisch, Pike and Hamada discloses or suggests each of the limitations of claim 14, which requires, among other things:

> causing a second beam of light to be directed through said reference grating onto said surface to be measured, said second beam of light having said wavelength λ and casting a second reference grating shadow onto said surface to be measured, said second reference grating shadow forming a second effective specimen grating, said second beam of light being phase-shifted with respect to said first beam of light.

The Applicants respectfully submit that none of the cited references discloses this limitation.

In sum, the Applicant respectfully submits that the Office Action has failed to set forth a *prima facie* case of obviousness, because (i) the combination of the three references fails to disclose each and every element of claims 1 through 28, and (ii) because the Office Action does not establish that one of ordinary skill in the art would have been motivated to combine Hamada with Jaerisch and Pike to arrive at the invention recited by claims 1 through 28.

In view of the foregoing, the Applicant submits that all of the presently pending claims are in condition for immediate allowance. In the event that the present application is not deemed to be in condition for allowance, the Examiner is invited to contact the undersigned in an effort to advance the prosecution of this application.

Respectfully submitted,

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